THE EFFECT OF REDUCED ATMOSPHERIC PRESSURE AND SEVERAL GASES ON THE TICK ORNITHODOROS PAPILLIPES BIR.

TRANSLATION NO. 1377

June 1965

UNITED STATES ARMY
BIOLOGICAL LABORATORIES
FORT DETRICK, FREDERICK, MARYLAND

THE EFFECT OF REDUCED ATMOSPHERIC PRESSURE AND SEVERAL GASES ON THE TICKS ORNITHODOROS PAPILLIPES BIR.

[Following is the translation of an article by Academy Member Ye. N. Pavlovskiy and I. K. Teravskiy, S. M. Kirov Military-Medical Academy, published in the Russian-language periodical Doklady Akademii Nauk SSSR (Proceedings of the Academy of Sciences, USSR), 1956, Vol 109, No 6, pages 1133-1135. It was received on 19 Jun 1956. Translation performed by Sp/6 Charles T. Ostertag Jr.]

For the present experiments, the aim of which was to explain the effect of several gases and reduced atmospheric pressure on Ornithodoros papillipes ticks, we took adult ticks (males and females) and stage IV and V nymphs, which we placed in glass chambers with two outlet tubes with a valve (see figure 1, B). We passed oxygen, hydrogen, nitrogen, carbon dioxide and hydrogen sulfide through the chambers for 10-15 minutes and observed their effect on ticks for several weeks. For the experiments with reduced atmospheric pressure we used glass chambers with one outlet tube with a valve (figure 1, A). Air was pumped out of the chambers with an oil pump.

1. The effect of reduced atmospheric pressure on ticks. From 10-18 ticks (males and females) were placed in chambers with one outlet tube. Air was pumped from the chambers until it was possible to attain the minimum residual pressure (from 0.01 to 100 mm mercury column), and then air was admitted into the chambers over a different period of time and the conduct of the ticks was observed prior to and after the admission of air into the chambers.

In chamber No. 1, where 18 ticks were placed, the air was almost completely pumped out (the residual pressure comprised 0.01 mm mercury column); during the first minutes of the experiment the ticks lost their mobility and in no way reacted to energetic shaking or heating by an electric bulb. After 8 hours, air was admitted into the chamber and the walls of the chamber became covered with moisture. At this moment all of the ticks were immobile and only after 6-7 hours began to display some activity; one tick died. On the 20th day of the experiment all the ticks died.

In another case the air in three chambers was pumped out until a residual pressure of 8 mm mercury column was achieved. During this, the ticks turned out to be somewhat stimulated (they were lively crawling along the sides of the chamber); then they fell into the usual torpid state and began to stir only during a warming of the chamber by an electric bulb or during energetic shaking. Air was admitted into the chambers by turns on the 2nd, 5th and 7th days of the experiment. In the first case, out of 10 experimental ticks 9 survived (acquired mobility) and 1 tick died on the 12th day after the admission of air. In the second case 5 ticks survived and 5 died on the 17th

day of the experiment. In the third chamber all 10 ticks died. Four of these were already dead on the day air was admitted into the chamber (7th day of experiment); the remaining ticks died 8-10 days later.

All the surviving ticks in this experiment remained immobile for the first 5-10 days after admission of air into the chambers. Many of these lay on their back with crooked legs and only gradually their mobility was restored though they could not straighten out the extremeties completely. The dead ticks took on a reddish hue; apparently, diffusion of the contents of the intestines into the body cavity occurred, since all the internal organs and hemolymph in such ticks proved to be an orange or reddish color.

Analogous experiments were set up with a residual pressure of 20 and 100 mm mercury column. In both cases the ticks maintained mobility for the first 5-6 days and were even somewhat more lively than usual. The ticks endured a vacuum with a residual pressure of 20 mm mercury column for three days without apparent changes (all the ticks survived); the residence of ticks under these conditions for a period of 6 days leads to the death of some of them (around 10%), and residence for a period of 12 days -- to the death of approximately 40% of the ticks. Reduction of atmospheric pressure to 100 mm mercury column was endured over a period of 20-24 days without any after effects.

All these observations speak for the considerable sturdiness of the ticks to a deficiency of air, and explain why after plastering adobe or stone walls, Ornithodoros papillipes and O. lahorensis ticks may stay alive up to a year under a layer of dry timber (2).

2. Effect of oxygen on ticks. Oxygen (from an oxygen cylinder) was passed through the chambers with two outlet tubes for 15 minutes. For the first 30-40 minutes the ticks were clearly stimulated; they crawled lively about the chamber and then fell into their usual semitorpid state, from which they could be brought out by warming the chamber near a bulb or by shaking. In the next 2-25 days the condition of the ticks remains without apparent changes, but subsequently the ticks begin to die if they are not given a fresh portion of oxygen or air. It is necessary to assume that these terms are extremely rough and depend on the volume of the chamber and the number of ticks in it (in our experiments the volume of the chamber together with the outlet tubes was 30 cm^3 and there were 10 ticks in each chamber). When a fresh portion of air was given on the 18th day of the experiment, all the ticks remained alive, when air was given on the 23rd and 28th days of the experiment in both cases 4 ticks out of 10 died. When air was given on the 35th day of the experiment only 2 ticks remained alive and 8 died.

Repeated experiments with oxygen yielded close results.

3. Effect of hydrogen on ticks. The gas was passed through the chambers for 15 minutes from a KIP apparatus [probable meaning of KIP - control and measuring instruments]. At first the gas didn't exert a noticeable influence on the ticks, but then the ticks lost their mobility and on the

4-5th day died. When air was put into the chamber in 24 hours, all the ticks survived; when air was put in after 48 hours, a partial death of ticks was observed (in two series of tests 6 ticks died the first time and all 10 ticks the second time), and when air was put in on the 3rd day of the test, all the ticks died (out of 20 test ticks in two chambers, only one survived).

4. Effect of nitrogen on ticks. The nitrogen was taken from a cylinder (it contained 1.5-2% oxygen). The gas was passed through the chambers for 15 minutes; during the first hours and days no noticeable influence was exerted on the ticks; they maintained activity for a period of 5-7 days, and in one experiment even up to 14 days. Subsequently without oxygen, the ticks died on the 15th-20th day of the experiment. When air was put into a chamber on the 7th day of the experiment all the ticks survived, and in another one 2 ticks died. When air was put in on the 16th day, 6 survived and 4 died.

5. Effect of carbon dioxide on ticks. The gas for the experiment was obtained in a KIP device. In the very first minutes of existence in an atmosphere of carbon dioxide the ticks lost mobility and did not react to any stimulation. They remained in such a state for the entire period of time of their existence in an atmosphere of the gas right up until death which began on the 3rd day of the experiment. When air was put into the chamber after four hours, the partial death of ticks was observed (2 ticks died out of 10). When air was admitted after 24 hours, 6 ticks died and 4 survived; when air was admitted after 48 hours, 9 died and one survived. When air was admitted on the 3rd day of the experiment and later, all the ticks died.

6. Effect of hydrogen sulfide on ticks. The gas was obtained in a KIP device and passed through the chamber for 10 minutes. Already in 30 seconds the ticks were in a stupor and lay with straightened extremities, not responding to even the most energetic stimulation. As further observation showed, a 10-12 minute residence in an atmosphere of hydrogen sulfide was sufficient to kill the ticks. The chitin and internal organs of such ticks acquired a greenish color (especially the tracheae), and the smell of gas remained a long time. In one of the chambers which had stood in the open for 3 days, but was not washed after the previous experiment, ticks were placed; after two hours in the chamber all the ticks died (in the chamber a sufficiently strong smell of hydrogen sulfide was preserved).

The above stated facts are presented in table 1.

Sex and age did not exert a noticeable influence on the endurance of ticks in regards to the various gases. Engorged ticks were somewhat more resistant to the toxic effect of gases, but they died, only in later periods than starved ticks.

CITED LITERATURE

1. Ye. N. Pavlovskiy, Tick-borne Relapsing Fever in Iran, in the book: Epidemiological-Parasitological Expedition in Iran and Parasitological Investigation, Izd. AN, USSR, Moscow, 1948.

2. Ye. F. Sosnina, Zoological Journal, 28, No. 4, (1949).

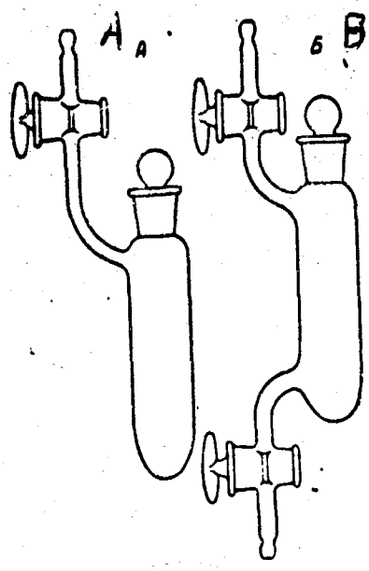

Figure 1. A. -- Glass chamber for experiments with air pumped out.
B. -- Glass chamber for experiments in an atmosphere of various gases.

Table 1

Condition of experiment	Exposure to toxic effects of gas or lowered atmospheric pressure *		Period of death of ticks, days from the beginning of the experiment
	Minimum	Maximum	
Vacuum (residual pressure 8 mm mercury column)	40-48 hrs	7 days	4-17
Hydrogen	30-40 hrs	3 days	4-5
Nitrogen	7-10 days	16-20 days	20-25
Carbon dioxide	3-4 hrs	2-3 days	4-10
Hydrogen sulfide	8-10 min	12-15 min	1-2

* For the minimum exposure, the duration of action of the gas is used during which all the ticks survived, and for the maximum -- the duration during which they all died.